Nutritional aspects of fruit and vegetable consumption

Lintas C.

in

Lauret F. (ed.).
Les fruits et légumes dans les économies méditerranéennes : actes du colloque de Chania

Montpellier : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 19

1992
pages 79-87

Nutritional aspects of fruit and vegetable consumption

Claudia LINTAS
Istituto Nazionale della Nutrizione, Rome (Italy)

Résumé. Aspects nutritionnels de la consommation des fruits et légumes. *Présentation de la classification et de la valeur nutritionnelle des légumes et des fruits. Influence des toxiques naturels et résiduels sur la qualité des produits. Attitudes des consommateurs.*

Abstract. Fruit and vegetables are classified according to type and nutritive value. The influence of natural and residual toxicants on product quality is discussed. Consumer attitudes are analyzed.

Key words. Fruit – Vegetables – Human nutrition – Consumption – Quality.

I. – Vegetables

Everyone knows what "vegetables" are and yet they defy exact classification or description. Different portions of plants are used for food. There is no biological structure common to vegetables to determine their chemical composition as is the case, for example, of cereal grains. Nevertheless, despite the wide variety of botanical structures, vegetables all possess the same general nutritive properties, at least in qualitative terms.

Appetizing and palatable vegetables need good quality produce and careful food preparation. Overcooked, woody-textured, and soggy vegetables are not appetizing and are usually refused.

Rapid transport, and canning and freezing processes have largely eliminated the regional and seasonal factors in availability. Sources of supply vary with the season; the development of vegetable crops in different locations has also diversified supply. Prices are lowest in markets with abundant local supply. Scarcity or abundance of a commodity regulates the price more than any other factor.

Home food freezers and refrigerators with enough space for storing frozen foods have changed buying habits. However, the fresh vegetable flavor remains the main criterion for judging vegetables, whether they are fresh, frozen, or canned.

1. Classification by nutritive value

Vegetables may be classified according to the portion of the plant used for food and its specific nutritive value *(Table 1)*.

A. Leaf vegetables

Lettuce, romaine, chicory, escarole, endive, cabbage, and all greens are examples of leaf vegetables. They are a valuable source of minerals (iron and calcium), vitamins (A, C, K, and riboflavin), and cellulose.

Young, tender, growing leaves contain more vitamin C than mature plants. The green outer leaves of lettuce and cabbage are richer in vitamin A, calcium, and iron than the white inner leaves; the thinner and greener the leaf, the richer its nutritive value. Green leaf vegetables are generally low in calories.

B. Stem or stalk vegetables

Celery and asparagus are examples of stem vegetables. Similar to leaf vegetables, they contain minerals and vitamins in proportion to the green color. Asparagus is a particularly good source of folic acid.

C. Flowering and fruit vegetables

Broccoli, cauliflower, and globe artichoke are the most commonly used flowering vegetables. Broccoli, being greener, rates higher in nutritive value than cauliflower and is a good source of iron, phosphorus, vitamins A and C, and riboflavin. Cauliflower is also a good source of vitamin C. The outer leaves of cauliflower and broccoli are much higher in nutritive value than the flower buds and should be cooked or used in salads. Artichoke is a good source of minerals, particularly potassium, calcium, and phosphorus, and has a high dietary fiber content (of which over 50% is soluble). Tomato and pepper are the most common fruit vegetables. Both are rich in vitamin C. Other fruit vegetables are cucumber, squash, pumpkin, and eggplant. Deep green or yellow color indicates high ß-carotene content.

D. Root vegetables

Carrot, beet, turnip, and potato are examples of root vegetables. Yellow and orange varieties are rich in ß-carotene, the precursor of vitamin A. The deeper the yellow color, the higher the ß-carotene content. Root vegetables in general are good sources of thiamin and minerals. Potato contains some vitamin C and can add significantly to the total daily allowance when it is consumed in sufficient quantities. Onion is an outstanding example of a bulb vegetable, and contains a moderate amount of vitamin C.

Table 1. Nutrients supplied by different classes of vegetables

Class	Vegetables	Nutrients[a]
Green vegetables		
Leaf vegetables	Beet, cabbage, chicory, salad greens, spinach	DF, V, M
Stem vegetables	Asparagus, cardoon, celery	V, M
Fruit and flower vegetables	Artichoke, eggplant, broccoli, cauliflower, zucchini, cucumber, mushroom, pepper, tomato	DF, V, M
Root vegetables		
Root, bulb, and tuber vegetables	Beet, carrot, fennel, onion, potato, radish, turnip	DF, CC, V, M

a. CC: complex carbohydrates; DF: dietary fiber; M: minerals; V: vitamins

2. Composition and nutritive value of vegetables

Vegetables have a low energy value. They generally provide between 10 Kcal and 50 Kcal (40–200 Kj) per 100 g; to obtain about 1000 Kcal, it would be necessary to eat about 2–3 kg. Their nutritional advantage is that they offer a high concentration of micronutrients for low contents of calories and fat. Virtually every national or international report on diet and health recommendations calls for an increase in fruit and vegetable consumption to replace high-energy foods.

All vegetables have a high water content, which ranges from 79% in potato to 96% in cucumber *(Table 2)*. They vary in chemical composition even within one variety, depending on the species, conditions of growth, and method of cooking. Vegetables are generally rich in carbohydrates but not in proteins (1–5%) and lipids (0.1–1.0%).

Table 2. Mean chemical composition of vegetables (content per 100 g)

		Minerals		Vitamins		Energy	
Water (g)	79–96	Ca (mg)	10–170	ß-carotene (mg)	0.1–5.0	(Kcal)	10–85
Protein (g)	0.5–5.0	P (mg)	12–125	C (mg)	3–230	(Kj)	42–356
Fat (g)	0.1–1.0	Fe (mg)	0.2–8.0	B6 (mg)	0.1–0.2		
Carbohydrate (g)	0.5–18.0	Na (mg)	2–150				
Dietary fiber (g)	0.8–8.0	K (mg)	200–600				

Vegetables are composed chiefly of carbohydrates, mainly simple sugars and complex carbohydrates (starch and dietary fiber). The content ranges from 1–2% in the leaf and stem vegetables to 27% in sweet potato. Root vegetables have the highest carbohydrate content. Dietary fiber content ranges from 0.8% in cucumber to 8.0% in artichoke.

Most vegetables contain substantial amounts of minerals, particularly calcium, iron, and potassium. But mineral content is not an indicator of nutritive value as the presence of interfering substances (e.g., oxalic or phytic acid) can hinder bioavailability of these micronutrients (Godber, 1990). Much of the iron in vegetables would be lost but for the presence of vitamin C which aids its absorption.

All vegetables contain small amounts of the B-complex vitamins, but their nutritive value is mainly derived from the supply of ß-carotene, vitamin C, and folic acid. Although most vegetables contribute to the formation of vitamin A, their ß-carotene content varies and is generally linked to color. All vegetables contain substantial amounts of vitamin C, but the quantity varies and much of it is lost during cooking and preparation *(Figure 1)*.

The exact nutrient content of fresh vegetables off the shelf cannot be determined because of a high degree of variation. Sources of variation include genetic potential, crop growth and cultural conditions, maturity at harvest, postharvest handling and storage conditions, and type as well as degree of processing (Shewfelt, 1990).

II. – Fruit

No other class of foods has such a variety of pleasant and attractive flavors. With their delicate coloring, fruits please the eye as well as the palate. Modern methods of transport and refrigeration make it possible to have fresh fruit practically all year round. As a consequence, consumption of citrus fruit has increased considerably over the past century. Even so, studies reveal that many children and adults do not consume enough vitamin C not because of cost or availability, but because they are often unaware of its nutritive value and sources.

1. Composition and nutritive value of fruit

The carbohydrates in fruit have a moderate energy value. Fruit contain protective vitamins and minerals, and dietary fiber but very little protein *(Table 3)*. They are practically fat-free except for avocado and olive, both of which contain up to 15% of fat.

Figure 1. Contents of vitamins A and C in fresh vegetables

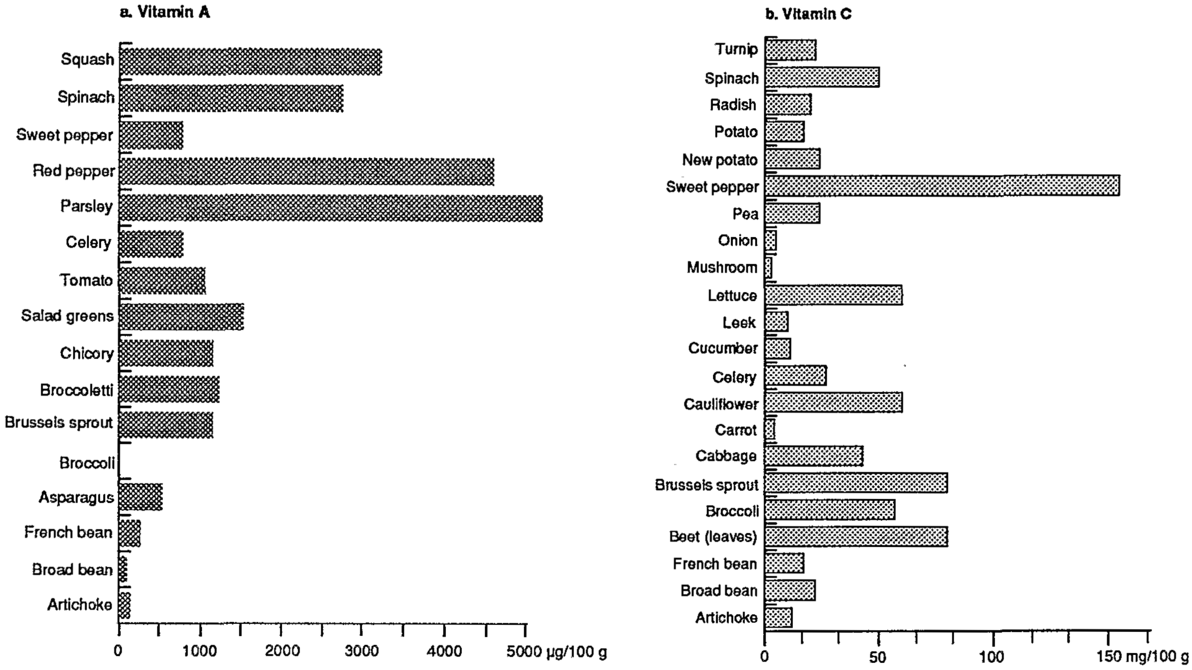

Figure 2. Contents of vitamins A and C in fresh fruit

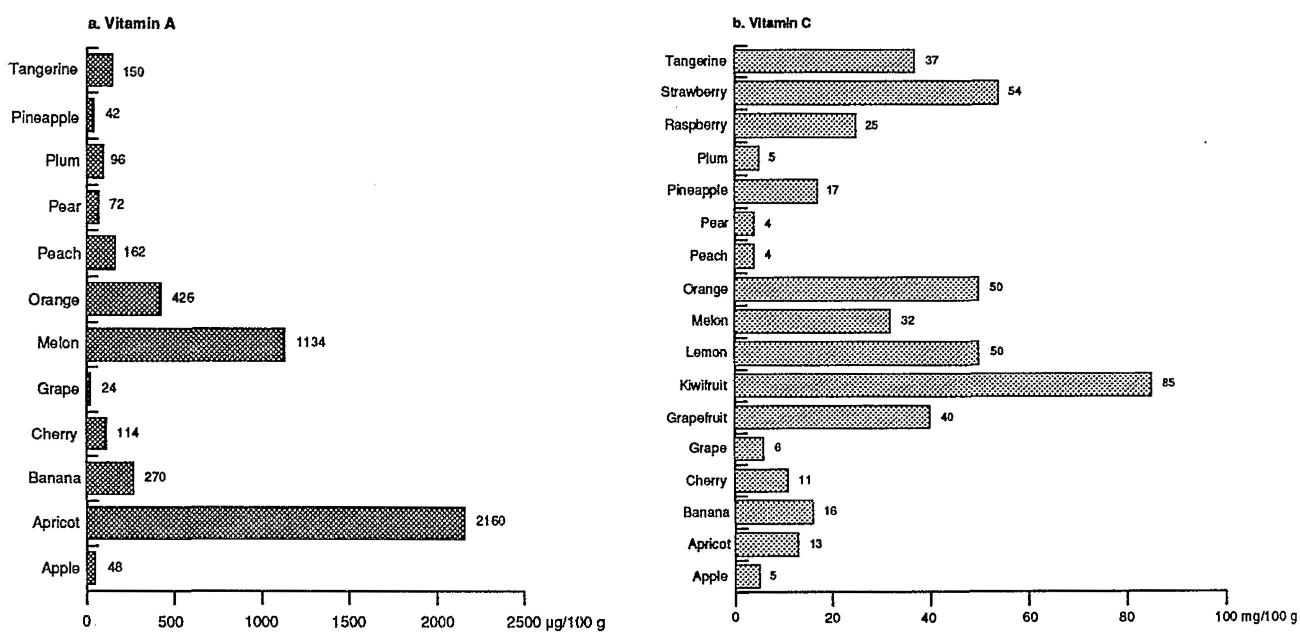

Table 3. Mean chemical composition of fresh fruit (content per 100 g)

		Minerals		Vitamins		Energy	
Water (g)	80 – 95	Ca (mg)	6 – 50	ß-carotene (mg)	0.2 – 2.0	(kcal)	6 – 66
Protein (g)	0.5 – 1.5	Fe (mg)	0.3 – 1.0	C (mg)	10 – 90	(kj)	25 – 276
Fat (g)	0.1 – 1.0	K (mg)	110 – 450	B6 (mg)	0.03 – 0.35		
Carbohydrate (g)	1.5 – 16.0						
Dietary fiber (g)	0.2 – 6.4						

Fruit vary widely in their carbohydrate content (between 1.5% and 26%). Ripe fruit contain no starch; the main sugars are fructose and glucose which are often present in equal proportions. Apple and pear contain more fructose, while apricot and peach also contain sucrose. Like vegetables, fruit also contain dietary fiber. Various organic acids in unripe fruit produce the typical sour taste. During ripening concentration of these acids falls and that of sugars rises.

Vitamin C is present in all fresh fruit, but strawberry, citrus fruit, and particularly kiwifruit are outstanding sources of this vitamin *(Figure. 2)*. For example, one kiwifruit or medium-size orange supplies the normal daily requirement for adults. Apple and peach provide moderate amounts of vitamin C and can contribute substantially to the diet when consumed in sufficient quantity.

Most fruit also supply varying amounts of ß-carotene and the B-complex vitamins. Yellow fruit, such as cantaloupe and apricot, are good sources of vitamin A, whereas plum and dried fruit (those not treated with sulphur dioxide) are the best sources of thiamin. Although the amounts are not sufficiently high to significantly increase intake of these nutrients in a mixed diet, under certain circumstances they may be very valuable.

Fruit contribute appreciable amounts of iron and calcium. Calcium is found in small amounts in citrus fruit; the whole fruit contains double the amount contained in an equal quantity of juice. Strawberry and dried fig also contain calcium. Sodium, magnesium, and potassium, which account for the alkaline ash of fruit when metabolized by the body, are also present in varying amounts in most fruit.

As in the case of vegetables, careful preparation and storage are essential to retain the maximum nutritive value of fruit. Some of the nutritive value is lost during cooking, drying, and canning, but the losses are not as high as they were once supposed. Frozen fruit compare favorably in vitamin content with fresh ones. Bruising and cutting of fruit, and exposing fruit and fruit juices to air cause considerable loss of vitamin C.

III. – Quality of fruit and vegetables

There is growing interest and concern among people from all walks of life in foods and their relationship to nutrition and disease (Downey, 1987). Food security used to be the primary concern of countries and individuals alike. But as agricultural research succeeds in alleviating the effects of disease and adverse climate, food security is generally not perceived as a problem any longer; instead, concern over quantity has been replaced by preoccupation with quality (Chow, 1979). Simultaneously, people are growing more conscious about issues such as ecology, energy conservation, and food production and processing methods.

1. Consumer attitudes

Valued as essentiel components of a nutritious diet, fruit and vegetables are condemned as unsafe carriers of pesticide residues. They are sought for specific attributes but show wide variation in composition as raw agricultural commodities.

Consumer attitudes to food safety and wholesomeness need to be considered, particularly those related to practices and techniques used in agriculture and the food industry. The risks, ranked according to their gravity, are:

- microbiological contamination,
- nutritional imbalance,
- environment pollutants and contaminants,
- natural toxicants,
- pesticide residues,
- food additives.

Extremist consumers and media hold food additives, pesticide residues, and environment contaminants as top priorities. According to Gray (1985) the only change since Hall's work in 1971 is perhaps an increasing awareness of the importance of nutrition-related issues.

Studies in a number of developed countries confirm that consumers are poorly informed and are confused about health-related food issues. A major factor appears to be the poor quality and low credibility of information available to the consumer.

Consumer attitudes to agricultural and food industry practices are often marked by concern, confusion, and, again, lack of accurate information. A number of studies (MNHW, 1980; Crawford et al., 1984; BNF, 1985) indicate that the need for food additives and their safety are the main concerns among consumers.

2. Natural toxicants in plant foods (nature's pesticides)

Many plants used as foods synthesize toxic chemicals to defend themselves against pests and diseases. The effect of these toxins on human health is largely unknown, but the consensus among toxicologists is that they are grossly underrated as a food hazard (Curtis, 1986). Two major review articles (Ames, 1983; Curtis, 1986) recently dealt with this subject in detail and provided background information to develop some of the current issues *(Table 4)*. According to Curtis (1986) a major reason for underrating natural toxins is a "gut feeling" among plant breeders, food scientists, toxicologists, and consumers that natural is synonymous with safe and wholesome. As a result, there is little incentive to investigate these compounds. Exceptionally, a consumer scare about specific toxins, such as the one that occurred recently in the UK (Davies and Blincow, 1984), will prompt investigation.

Table 4. Natural toxicants in plant foods

Protease inhibitors	Legumes, potato
Lectins	Beans, lentils, pea
Saponins	Spinach, asparagus
Glucosinolates	Cabbage and related species
Cyanogenetic glucosides	Pea, beans, fruit kernels
Vicine and convicine	Broad bean
Glycoalkaloids	Potato
Hydrazine derivates	Mushroom

Only a few natural toxicants have been studied for their long-term effects even at "safe" levels. Increased interest among regulatory agencies in recent years has led to the identification of many natural mutagens, teratogens, and carcinogens in the human diet (Ames, 1983). They include: glycoalkaloids in potato, vicine and convicine in broad bean, a hydrazine derivative in mushroom, lupine in some legumes, theobromine in cocoa, safrole and related compounds in black pepper, etc. In addition, some ubiquitous toxins—quercetin and other flavonoids such as chlorogenic acid, quinones, and pyrrholizidine alkaloids—with different biological effects are found in a range of plant foods. However, it should be mentioned that plant foods also contain natural anticarcinogens *(Table 5)*.

Table 5. Natural anticarcinogens in plant foods

Compound	Action	Source
Vitamin E	Antioxidant	Vegetable oils
ß-carotene	Antioxidant	Vegetables and fruit
Selenium	Prevents lipid peroxidation	Cereals
Ascorbic acid	Antioxidant	Vegetables and fruit

Possible risks from toxicants introduced through breeding programs are of special relevance to technical change in agriculture. The implications of rapid changes in the genetic constitution of common fruit and vegetables have never been assessed (Curtis, 1986). Introduction of qualities such as disease resistance from wild types may result in the introduction, or increased levels, of natural toxicants.

3. Pesticides

Pesticides are chemicals or mixtures of chemicals used in agriculture for preventing, eradicating, or controlling unwanted species of plants or animals; they include plant growth regulators, defoliants, and desiccants. In modern intensive agriculture, pesticides are an important input. Chemically, they form a diverse group. As they are generally toxic, pesticides are subject to a number of regulations. As a result, the risk to consumers from pesticide residues in foods is generally considered to be negligible (Gray, 1985). According to Ames (1983) the human dietary intake of "nature's pesticides" (natural toxicants) is likely to be several grams per day, which is probably at least 10 000 times higher than the dietary intake of man-made pesticides. In addition, data from the UK and Germany indicate that the level of consumer exposure to pesticide residues is well below the limits of acceptable intake set by the World Health Organization (WHO) and it is steadily falling. Only the improper use of pesticides can present significant risks to public health. The National Research Council (NRC), United States, even recommended that Americans increase their consumption of fresh fruit and vegetables (NRC/NAS, 1989), stating that the potential benefits of increased consumption of such foods outweighed the potential low risk due to the resulting increased intake of pesticide residues.

Pesticide development focuses on greater specificity to individual pests, reduced persistence, better formulation, improved application (to reduce drift), clear labeling, etc. In the immediate future, intensive agriculture will continue to depend heavily on pesticides for economic reasons and because alternatives do not exist. Ecological pressure will enforce judicious use of pesticides and lead to further improvements in formulation and application techniques. It will also promote integrated control strategies.

4. Fertilizers

The major potential hazard to consumer health linked to fertilizers is the contribution of nitrogen fertilizers to nitrate levels in the food supply. Nitrates can be reduced to nitrites which then react with secondary amines to produce nitrosamines under the influence of acids in the stomach (Craddock, 1983). However, high vitamin C levels in vegetables can prevent the nitrosation reaction.

Large amounts of nitrate can accumulate in plants *(Table 6)*, particularly leafy plants (Lee et al., 1972), when excessive amounts of nitrogen fertilizer are applied as a top dressing during growth (Catliffe and Phatak, 1974). Normally nitrates are absorbed and metabolized by plants; they start to accumulate when the uptake rate is higher than that of reduction. The problem of nitrate levels in leafy vegetables is being addressed through the selection of low nitrate-accumulating cultivars. Further progress and practical applications of this work combined with adequate monitoring should contribute to lower nitrate levels in vegetables.

Table 6. Nitrate content of selected vegetables

Food	Minimum (mg/kg)	Maximum (mg/kg)
Lettuce	127	3 547
Spinach	238	2 397
Cabbage	204	918
Celery	1 001	2 829
Beet	1 218	3 010
Carrot	66	337
Radish	1 519	2 019
Cauliflower	420	1 054

5. Organically grown foods

Production of organically grown foods, or "organic farming," is part of a broad movement consisting of a spectrum of attitudes and practices with social, philosophical, and agronomic implications. At present, however, neither an official definition of nor standards for organically grown foods exist.

"Organic agriculture" is a term applied to crops with minimum or no inputs of synthetically derived agricultural chemicals. In general, the characteristics consumers associate with organic foods are: "no pesticide/herbicide" (83%), "no growth regulators" (52%), "no artificial fertilizer" (66%), "residue free" (46%) (Jolly et al., 1989). But until a uniform definition for organically grown foods is established, standards for production are developed, and labeling of these foods is regulated, consumers cannot be assured that all food currently sold as "organic" or "organically grown" is indeed free from chemical residues.

The claim that organically grown foods taste better and are nutritionally superior or "healthier" compared with conventionally grown foods has not been scientifically established. The type of fertilizer can affect the mineral levels in plants and, in a few specific crops, the carbohydrate content. However, the type of fertilizer does not influence nutrient levels with respect to protein, fat, or vitamin content. Moreover, all raw foods vary widely in their vitamin and mineral contents because of differences in genetic characteristics, climatic or soil conditions, maturity at harvest, and postharvest handling conditions.

The few studies that compared the quality of organic and conventional produce did not find significant advantages in organic products for either consumption quality or nutritional composition (Appledorf et al., 1974; Schutz and Loren, 1976).

References

- Adorisio (S.), Lintas (C.), Cappelloni (M.), Monastra (F.), 1990.- Caratteristiche nutrizionali di frutti di actinidia prodotti in Italia.- *Frutticoltura* LII:61.
- Ames (B.N.), 1983.- Dietary carcinogens and anticarcinogens.- *Science* 221:1256-64.
- Appledorf (H.), Pennington (J.), Wheeler (W.B.), Koburger (J.A.), 1974.- Sensory evaluation of health foods: A comparison with traditional foods.- *J. Milk Food Technol.* 37:392.

- British Nutrition Foundation (BNF, London), 1985.- Eating in the early 1980s. Attitudes and behaviour: Main findings.- UK: BNF.- 75 pp.
- Canada: Ministry of National Health and Welfare (MNHW), 1980.- Food additives: What do you think? Report on opinion survey conducted in summer 1979.- Canada: MNHW.- 57 pp.
- Catliffe (D.J.), Phatak (S.C.), 1974.- Nitrate accumulation in greenhouse vegetable crops.- *Can. J. Plant Sci.* 54:783-88.
- Chow (M.), 1979.- The preoccupation with food safety.- Pages 14-42 *in* Critical food issues for the eighties (M. Chow, TDP Harmon Jr, eds.), New York, USA: Pergamon Press.
- Craddock (V.M.) , 1983.- Nitrosamines and human cancer: Proof of an association?.- *Nature* 306:638.
- Crawford (D.), Morsley (A.), Peters (M.), 1984.- Is food a health hazard? Australians' beliefs about the quality of food.- *Food Technol. in Australia* 36:414-17.
- Curtis (R.F.), 1986.- Diet a source of nutritional toxicants.- Pages 822-826 *in* Proc. XIII Int. Cong. Nutrition, 1985, Brighton).
- Davies (A.M.C.), Blincow (P.J.), 1984.- Glycoalkaloid content of potatoes and potato products sold in the UK.- *J. Sci. Food Agric.* 35:553-57.
- Downey (G.), 1987.- Review and assessment of food and nutrition policies.- Pages 121-212 *in* Food, health and the consumer (T.R. Gormely, G. Downey, D. O'Beirne, eds.) Elsevier Applied Science.
- Godber (J.S.), 1990.- Nutrient bioavailability in humans and experimental animals.- *J. Food Qual.* 13:21.
- Gray (J.), 1985.- How safe is your diet: General review.- *Chem. Ind.* Mar. 4:146-148.
- Jolly (D.A.), Schutz (H.G.), Diaz-Knauf (K.V.), Johal (J.), 1989.- Organic foods: Consumer attitudes and use.- *Food Technol.* 43: 60-66.
- Lee (C-Y), Stoewsand (G.S.), Downing (D.L.), 1972.- Nitrate problems in foods.- *NY Food and Life Sci.* 5:8.
- National Research Council, National Academy of Sciences (NRC/NAS), 1989.- Diet and health implications for reducing chronic disease risk.- Washington DC, USA: NRC/NAS.
- O'Beirne (D.), 1987.- Review and assessment of agricultural production and food processing technologies with respect to their possible impact on human health.- Pages 213-298 *in* Food, health and the consumer (T.R. Gormely, G. Downey, D. O'Beirne, eds.) Elsevier Applied Science.
- Schutz (H.G.), Lorenz (O.A.), 1976.- Consumer preferences for vegetables grown under "commercial" and "organic" conditions.- *J. Food Sci.* 41:70.
- Shewfelt (R.L.), 1990.- Sources of variation in the nutrient content of agricultural commodities from the farm to the consumer.- *J. Food Qual.* 13:37.